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披针叶胡颓子中的一个新木脂素*

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摘要：从披针叶胡颓子（*Elaeagnus lanceolata*）的干燥枝叶中分离得到19个化合物，其中isoamericanol B（**1**）为一新化合物，经波谱学方法鉴定其结构为rel-(7′Z)-(7β，8α)-3-methoxy-4，9′-dihydroxy-3′，7-epoxy-8，4′-oxyneolign-7′-ene。

关键词：披针叶胡颓子；木脂素；isoamericanol B
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A New Lignan from *Elaeagnus lanceolata* (Elaeagnaceae)

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Abstract：A new compound，namely isoamericanol B (**1**)，together with 18 known compounds were isolated from the dry leaves and twigs of *Elaeagnus lanceolata*. The structure of **1** was determined to be rel-(7′Z)-(7β，8α)-3-methoxy-4，9′-dihydroxy-3′，7-epoxy-8，4′-oxyneolign-7′-ene on the basis of detailed spectroscopic analysis.

Key words：*Elaeagnus lanceolata*；Lignan；isoamericanol B

Elaeagnus lanceolata Warb. ex Diels belongs to the genus *Elaeagnus* (Elaeagnaceae)，which comprises about 80 species and widespread in subtropical and temperate areas of East and Southeast Asia，among them 55 species are found in China (Editorial Board of Flora of China of Chinese Academy of Sciences，1979). Leaves，fruits，and roots of *E. lanceolata* have been used to treat cough，asthma，dysentery and congestion (Editorial Board of National Herbal Compendium，1975). Four flavonol glycosides and a phenylpropanoid were reported from the leaves of this plant before (Cao *et al.*，2001). As part of our ongoing program on discovering natural skin care products from Traditional Chinese Medicine，a thorough chemical work was carried out on this plant. A new lignan，isoamericanol B (**1**)，together with 18 known compounds were isolated from the dry leaves and twigs of *E. lanceolata*. These known compounds were identified to be 6-hydroxy-3，4-dihydro-1-oxo-β-carboline (**2**)，2α-hydroxy-ursolic acid (**3**)，2α，23-dihydroxy-ursolic acid (**4**)，maslinic acid (**5**)，vomifoliol (**6**)，roseoside

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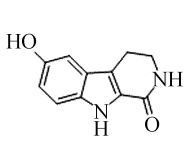
(**7**), syringaresinol (**8**), clemaphenol A (**9**), japonica acid (**10**), lutein (**11**), trilobatin (**12**), 3-phenyl-1-(2′, 6′-dihydroxy-phenyl-4′-*O*-β-*D*-glucopyranosyl)-1-propanone (**13**), naringenin-7-*O*-β-*D*-glucopyranoside (**14**), vitexin (8-*C*-β-*D*-glucopyranosyl apigenin) (**15**), 7-*O*-β-*D*-glucopyranosyl chrysin (**16**), isorhamnetin 3-*O*-α-*L*-rhamnopyranosyl-7-*O*-β-*D*-glucopyranoside (**17**), kaempferol-3-*O*-β-*D*-glucopyranoside (**18**) and kaempferol-3-*O*-β-*D*-(6″-*O*-trans-p-coumaroyl) glucopyranoside (**19**) (Fig. 1, 2). Compounds **2**-**17** were isolated from this plant for the first time. Here, we reported the isolation and structure elucidation of the new compound.



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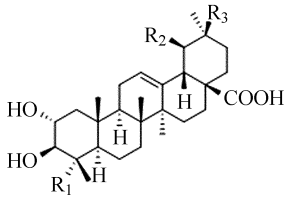
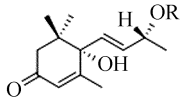
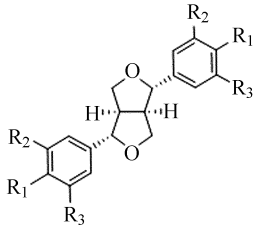


3 $R_1=R_2=CH_3$, $R_3=H$
4 $R_1=CH_2OH$, $R_2=CH_3$, $R_3=H$
5 $R_1=R_3=CH_3$, $R_2=H$



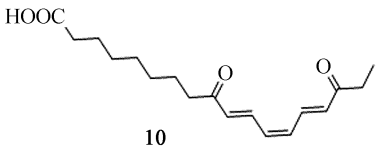
6 R=H
7 R=β-*D*-Glc



8 $R_1=OH$, $R_2=R_3=OCH_3$
9 $R_1=OCH_3$, $R_2=OH$, $R_3=H$

Results and Discussion

Isoamericanol B (**1**), was obtained as colorless amorphous solid, which was shown to possess a molecular formula as $C_{19}H_{20}O_5$ by positive HR-ESI-MS at *m/z* 351.1205 $[M+Na]^+$ (calcd. for $C_{19}H_{20}O_5Na^+$, 351.1208), indicating ten degrees of unsaturation. The IR spectrum showed absorptions at 3 432, 1 580, 1 505 cm^{-1}, suggesting the presence of hydroxyl group, double bond and aromatic moiety.



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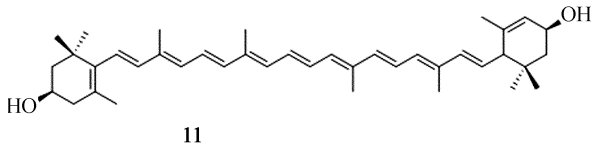
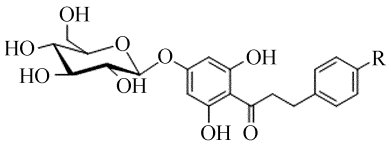
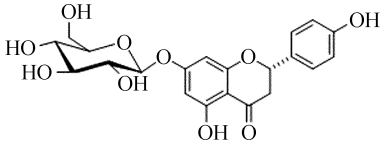


11

Fig. 1 Structures of compounds **2**—**11**



12 R=OH
13 R=H



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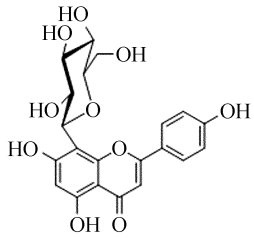

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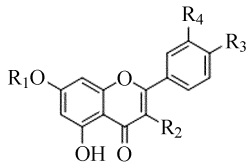

16 R_1=β-*D*-Glc, $R_2=R_3=R_4=H$
17 R_1=β-*D*-Glc, R_2=*O*-α-*L*-Rha, $R_3=OH$, $R_4=OCH_3$
18 $R_1=R_4=H$, R_2=*O*-β-*D*-Glc, $R_3=OH$

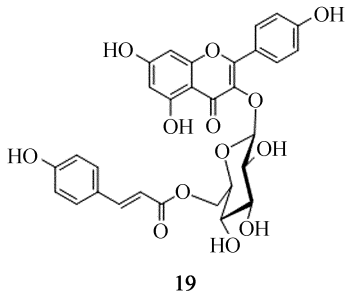

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Fig. 2 Structures of compounds **12**—**19**

In the ^{13}C-NMR spectrum of **1** (Table 1), 19 carbon signals were observed, including one methyl (δ_C 13.6), one methoxy (δ_C 56.4), one oxygen-bearing methylene (δ_C 60.0), two oxygen-bearing methines (δ_C 74.3, 78.5), as well as eight aromatic methines and six quaternary aromatic carbons, which belong to two phenyls and one disubstituted double bond (Table 1). The ^{1}H-NMR signals at δ_H 4.33 (dd, J = 6.3, 1.6), 5.72 (dt, J = 11.9, 6.3), and 6.42 (d, J = 11.7), ^{13}C NMR signals at δ_C 60.0 (t), 131.4 (d), and 130.8 (d) indicated the presence of one (*Z*) allyl alcohol unit, which was also confirmed by COSY spectrum. In the HMBC spectrum, correlations between H-9 and C-8, C-7, H-8 and C-4′, H-7 and C-3′, C-1, C-2, C-6 confirmed the structure fragment of benzodioxane. Further 2D NMR spectra data analysis (HSQC, COSY, and HMBC) suggested that compound **1** possess a neolignan skeleton, which was composed of two phenylpropanoids units connected by a 1, 4-dixoane ring (Fig. 3). The ^{1}H and ^{13}C NMR spectra data of **1** were very similar to those of isoamericanol A (Waibel *et al.*, 2003), except for the presence of one additional methoxy, one cis double bond, and one methyl in **1**, instead of one trans double bond and one hydroxymethyl in isoamericanol A (Fig. 4).

The relative stereochemistry of **1** was determined by the correlation between H-9 and H-7, observed in the ROESY spectrum of **1**, which established the *trans*-relationship between H-7 and H-8. Thus, the structure of **1** was elucidated as rel-(7′Z)-(7β, 8α)-3-methoxy-4, 9′-dihydroxy-3′, 7-epoxy-8, 4′-oxyneolign-7′-ene.

Experimental

General experimental procedures Optical rotation was measured on a JASCO P-1020 digital polarimeter. IR spectra were obtained from Bruker Tensor 27 FT-IR spectrometer with KBr pellets. UV spectra were determined on a Shimadzu UV2401PC spectrometer. ESIMS and HRESIMS spectra were recorded on AutoSpec Premier P776 and API QSTAR Pulsar instrument. NMR spectra were recorded on Bruker AM-400 and DRX-500 spectrometers with TMS as internal standard. Silica gel (200－300 mesh), Silica gel F_{254} (Qingdao Marine Chemical Co., Ltd), RP-18 silica gel (40－63 μm, Merck, Germany), MCI gel CHP-20P (75－150 μm, Mitsubishi Chemical Corporation, Tokyo) and Sephadex LH-20 (Pharmacia) were used for column chromatography. Fractions were monitored by TLC and spots were visualized by heating silica gel plates immersed with 10% H_2SO_4 in ethanol.

Table 1　^{1}H and ^{13}C NMR date of 1 and isoamericanol A in CD_3OD (δ in ppm, *J* in Hz)

NO.	**1**		Isoamericanol A	
	δC[a]	δH[b]	δC[c]	δH[d]
1	129.7 (s)		129.6 (s)	
2	111.1 (d)	6.96 (d, 1.6)	115.6 (d)	6.85 (d, 2.5)
3	149.0 (s)		146.6 (s)	
4	147.5 (s)		147.1 (s)	
5	118.1 (d)	6.83 (overlap)	116.4 (d)	6.80 (d, 8.5)
6	120.3 (d)	6.84 (overlap)	120.4 (d)	6.76 (dd, 8.5, 2.5)
7	78.5 (d)	5.08 (d, 2.5)	77.6 (d)	4.80 (d, 8)
8	74.3 (d)	4.50 (dq, 6.7, 2.5)	80.0 (d)	3.98 (ddd, 8, 5.5, 3)
9	13.6 (q)	1.03 (d, 6.7)	62.1 (t)	3.47 (dd, 12.5, 5.5); 3.66 (dd, 12.5, 3)
1′	131.6 (s)		132.0 (s)	
2′	118.4 (d)	6.84 (overlap)	115.6 (d)	6.95 (d, 2.5)
3′	144.2 (s)		144.6 (s)	
4′	142.9 (s)		145.3 (s)	
5′	116.1 (d)	6.82 (overlap)	117.9 (d)	6.88 (d, 8.5)
6′	123.6 (d)	6.74 (dd, 8.2, 2.0)	120.8 (d)	6.92 (dd, 8.5, 2.5)
7′	130.8 (d)	6.42 (d, 11.7)	131.4 (d)	6.48 (br.d 16)
8′	131.4 (d)	5.72 (dt, 11.9, 6.3)	128.1 (d)	6.20 (dt, 16, 6)
9′	60.0 (t)	4.33 (dd, 6.3, 1.6)	63.8 (t)	4.18 (dd, 6, 1.5)
OMe	56.4 (q)	3.79 (s)		

a) 125Hz; b) 500 Hz; c) 90 Hz; d) 360 Hz.

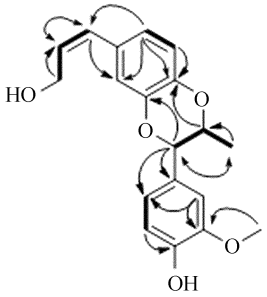
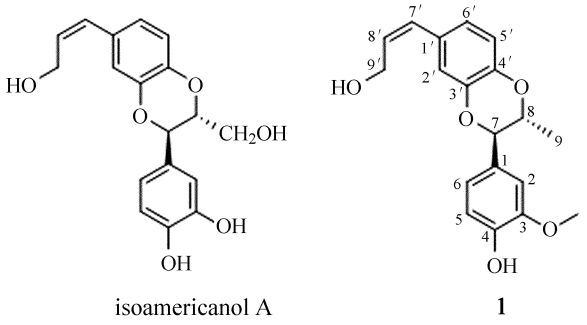


Fig. 3 The key HMBC (⟶), ^{1}H,^{1}H-COSY (▬) and ROESY (↶) correlations for compound **1**



isoamericanol A　　**1**

Fig. 4 Structures of compound **1** and isoamericanol A

Plant material The leaves and twigs of *Elaeagnus lanceolata* were collected in Yimen county of Yunnan Province, China, in September, 2008, and identified by Prof. Chen Yu, Kunming Institute of Botany, Chinese Academy of Sciences. A voucher specimen was deposited in the State Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences.

Extraction and isolation The air-dried leaves and twigs (7 kg) of *Elaeagnus lanceolata* were extracted with methanol at room temperature (4×40 L). The extracts were combined and concentrated, and the residue was dissolved in MeOH/H_2O (9∶1), and then successively partitioned with petroleum ether, chloroform and *n*-BuOH. The petroleum ether extract (149 g) was subjected to column chromatography over silica gel ($CHCl_3$/MeOH 100∶0→90∶10) to afford 3 fractions. Column chromatography of Fraction 2 over silica gel ($CHCl_3$/acetone 30∶1→7∶3) afforded **11** (30 mg). The chloroform extract (198 g) was subjected to column chromatography over silica gel ($CHCl_3$/MeOH 100∶0→70∶30) to afford 6 fractions A-F. Fraction B was repeatedly chromatographed over silica gel ($CHCl_3$/acetone 30∶1→7∶3 or petroleum ether/Acetone 9∶1→7∶3 or petroleum ether/EtOAc 9∶1→7∶3), MCI gel (MeOH/H_2O 5∶5→10∶0), Sephadex LH-20 (MeOH) and RP-18 (MeOH/H_2O 30∶70→100∶0) to afford **8** (20 mg), **10** (5 mg) and **9** (20 mg). In the same way, **2** (10 mg), **3** (60 mg), **4** (10 mg), **5** (65 mg) and **6** (18 mg) were isolated from Fraction C; **1** (12 mg), **13** (10 mg), **14** (20 mg), **16** (50 mg), **18** (45 mg) and **19** were obtained from Fraction D; **12** (369) was from Fraction E; **7** (10 mg), **17** (6 mg) and **15** (50 mg) were from the *n*-BuOH extract (296 g).

isoamericanol B (**1**, rel-(7′Z)-(7β, 8α)-3-methoxy-4, 9′-dihydroxy-3′, 7-epoxy-8, 4′-oxyneolign-7′-ene) was obtained as colorless amorphous solid, $C_{19}H_{20}O_5$; UV λ_{max}^{MeOH} (log ε): 286.4 (3.76), 259.4 (4.05), 216 (4.44), 204 (4.59) nm; $[\alpha]_D^{24}$ = +98.1 (*c* = 0.4, MeOH); IR ν_{max}^{KBr} (cm^{-1}): 3432, 2925, 2852, 1612, 1580, 1505, 1463, 1429, 1380, 1267; ^{1}H and ^{13}C-NMR: see Table 1; ESI-MS (positive) *m/z*: 351 $[M+Na]^+$, HR-ESI-MS (positive) *m/z*: 351.1205 $[M+Na]^+$ (calcd. for $C_{19}H_{20}O_5Na^+$, 351.1208).

6-hydroxy-3, 4-dihydro-1-oxo-β-carboline (**2**) was obtained as yellow powder, $C_{11}H_{10}N_2O_2$; ^{1}H-NMR (CD_3OD, 500 MHz): δ_H 7.27 (1H, d, *J* = 8.8, H-8), 6.90 (1H, d, *J* = 2.3, H-5), 6.84 (1H, dd, *J* = 2.3, 8.8, H-7), 3.61 (2H, t, *J* = 7.0, H-3), 2.93 (2H, t, *J* = 7.0, H-4); ^{13}C-NMR (CD_3OD, 100 MHz): δ_C 165.0 (s, C-1), 42.8 (t, C-3), 21.5 (t, C-4), 104.2 (d, C-5), 152.2 (s, C-6), 116.8 (d, C-7), 114.0 (d, C-8), 134.2 (s, C-9a), 127.9 (s, C-8a), 127.0 (s, C-4b), 120.2 (s, C-4a). (Salmoun *et al.*, 2002)

2α-hydroxy-ursolic acid (**3**) was obtained as white powder, $C_{30}H_{48}O_4$; ESI-MS *m/z*: 495 $[M+Na]^+$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 5.46 (1H, br. s, H-12), 4.10 (1H, ddd, *J* = 9.2, 9.2, 4.1, H-2), 3.40 (1H, d, *J* = 9.2, H-3), 1.27 (3H, s, H-23), 1.20 (3H, s, H-27), 1.07 (3H, s, H-24), 1.04 (3H, s, H-25), 0.98 (3H, d, *J* = 5.9, H-29), 0.97 (3H, s, H-26), 0.95 (3H, d, *J* = 5.9, H-30); ^{13}C-NMR (Pyridine-d_5, 100 MHz): δ_C 48.0 (t, C-1), 68.6 (d, C-2), 83.8 (d, C-3), 39.9 (s, C-4), 55.9 (d, C-5), 18.8 (t, C-6), 33.5 (t, C-7), 40.0 (s, C-8), 48.1 (d, C-9), 38.4 (s, C-10), 23.7 (t, C-11), 125.5 (d, C-12), 139.3 (s, C-13), 42.5 (s, C-14), 28.6 (t, C-15), 24.9 (t, C-16), 48.0 (s, C-17), 53.5 (d, C-18), 39.4 (d, C-19), 39.5 (d, C-20), 31.1 (t, C-21), 37.4 (t, C-22), 29.4 (q, C-23), 17.5 (q, C-24), 17.0 (q, C-25), 17.7 (q, C-26), 23.9 (q, C-27), 179.9 (s, C-28), 17.5 (q,

C-29), 21.4 (q, C-30). (Kim *et al.*, 2005)

2α, 23-dihydroxy-ursolic acid (**4**) was obtained as white amorphous powder, $C_{30}H_{48}O_5$; ESI-MS *m/z*: 511 $[M+Na]^+$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 5.45 (1H, t, *J* =4.0, H-12), 3.91 (1H, d, *J* =11.0, H-23α), 3.74 (1H, d, *J* =11.0, H-23β), 2.59 (1H, d, *J* =11.6, H-18), 1.12 (3H, s, H-27), 1.04 (3H, s, H-25), 0.98 (3H, s, H-26), 0.94 (3H, d, *J* =6.4, H-30), 0.91 (3H, d, *J* =6.4, H-29), 0.85 (3H, s, H-24); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 43.8 (t, C-1), 66.5 (d, C-2), 79.1 (d, C-3), 42.8 (s, C-4), 43.0 (d, C-5), 18.5 (t, C-6), 33.4 (t, C-7), 39.7 (s, C-8), 48.3 (d, C-9), 38.6 (s, C-10), 24.0 (t, C-11), 125.8 (d, C-12), 139.6 (s, C-13), 42.2 (s, C-14), 28.9 (t, C-15), 25.1 (t, C-16), 48.3 (s, C-17), 53.8 (d, C-18), 39.7 (d, C-19), 40.3 (d, C-20), 31.3 (t, C-21), 37.7 (t, C-22), 71.5 (t, C-23), 18.0 (q, C-24), 17.8 (q, C-25), 17.8 (q, C-26), 24.1 (q, C-27), 180.2 (s, C-28), 17.4 (q, C-29), 21.7 (q, C-30). (Fang *et al.*, 2008)

maslinic acid (**5**) was obtained as white amorphous powder, $C_{30}H_{48}O_4$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 5.48 (1H, br. s, H-12), 4.12 (1H, ddd, *J* =11.2, 9.4, 4.1, H-2), 3.41 (1H, d, *J* =9.4, H-3), 1.29, 1.27, 1.09, 1.03, 1.01, 0.99, 0.95 (each 3H, s, H-23 to 30); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 48.1 (t, C-1), 68.9 (d, C-2), 84.2 (d, C-3), 40.2 (s, C-4), 56.3 (d, C-5), 19.2 (t, C-6), 33.6 (t, C-7), 38.9 (s, C-8), 48.5 (d, C-9), 40.2 (s, C-10), 24.3 (t, C-11), 122.8 (d, C-12), 145.2 (s, C-13), 42.6 (s, C-14), 28.6 (t, C-15), 24.1 (t, C-16), 46.8 (s, C-17), 42.4 (d, C-18), 47.0 (t, C-19), 31.3 (s, C-20), 34.6 (t, C-21), 33.6 (t, C-22), 30.4 (q, C-23), 17.2 (q, C-24), 17.8 (q, C-25), 18.1 (q, C-26), 26.5 (q, C-27), 180.6 (s, C-28), 33.6 (q, C-29), 24.1 (q, C-30). (Taniguchi *et al.*, 2002)

vomifoliol (**6**) was obtained as white crystals, $C_{13}H_{20}O_3$; ESI-MS *m/z*: 225 $[M+H]^+$; ^{1}H-NMR ($CDCl_3$, 500 MHz): δ_H 5.86 (1H, s, H-2), 1.25 (3H, d, *J* =6.2, H-4′), 1.85 (3H, d, *J* =1.0, Me-C3), 1.04 (3H, s, Me_β-C5), 1.09 (3H, s, Me_α-C5), 4.36 (1H, m, H-3′); ^{13}C-NMR ($CDCl_3$, 100 MHz): δ_C 198.6 (s, C-1), 126.9 (d, C-2), 163.7 (s, C-3), 79.1 (s, C-4), 41.3 (s, C-5), 49.8 (t, C-6), 135.8 (d, C-1′), 129.1 (d, C-2′), 68.1 (d, C-3′), 24.2 (q, C-4′), 19.2 (q, Me-C (3)), 23.8 (q, Me_α-C5), 23.0 (q, Me_β-C5). (Siddiqui *et al.*, 2003)

roseoside (**7**) was obtained as colorless oil, $C_{19}H_{30}O_8$; ESI-MS *m/z*: 385 $[M-H]^+$; ^{1}H-NMR (CD_3OD, 500 MHz): δ_H 1.03 (3H, s, Me_α-C5), 1.04 (3H, s, Me_β-C5), 1.29 (3H, d, *J* =6.3, H-4′), 1.92 (3H, d, *J* =1.2, Me-C3), 2.14 (1H, d, *J* =16.8, H-6β), 2.52 (1H, d, *J* =16.8, H-6α), 3.14-3.86 (5H, m, H-2″, 6″), 4.34 (1H, d, *J* =7.8, H-1″), 4.42 (1H, m, H-3′), 5.85 (1H, s, H-2′), 5.86 (1H, br. s, H-1′), 5.87 (1H, m, H-2); ^{13}C-NMR (CD_3OD, 125 MHz): δ_C 201.2 (C-1), 127.1 (d, C-2), 167.3 (C-3), 80.0 (C-4), 42.4 (t, C-5), 50.6 (C-6), 131.5 (d, C-1′), 135.2 (d, C-2′), 77.2 (d, C-3′), 21.1 (C-4′), 102.7 (d, C-1″), 75.2 (d, C-2″), 78.0 (C-3″), 71.6 (d, C-4″), 78.0 (d, C-5″), 62.7 (t, C-6″), 24.6 (q, Me_α-C5), 23.4 (q, Me_β-C5), 19.5 (q, Me-C3). (Andersson and Lundgren, 1988)

syringaresinol (**8**) was obtained as white amorphous powder, $C_{22}H_{26}O_8$; ESI-MS *m/z*: 419 $[M+H]^+$; ^{1}H-NMR ($CDCl_3$, 500 MHz): δ_H 6.57 (4H, s, H-2′, 6′, 2″, 6″), 4.72 (2H, d, *J* =3.8, H-2, 6), 4.28-3.89 (4H, m, H-4, 8), 3.88 (12H, s, 4×OMe), 3.11-3.05 (2H, m, H-1, 5); ^{13}C-NMR ($CDCl_3$, 125 MHz): δ_C 147.1 (s, C-3′, 5′, 3″, 5″), 134.3 (s, C-4′, 4″), 132.0 (s, C-1′, 1″), 102.7 (d, C-2′, 2″), 86.0 (d, C-2, 6), 71.7 (t, C-4, 8), 56.3 (q, 2×OMe), 54.3 (d, C-1, 5). (Deyama, 1983)

clemaphenol A (**9**) was obtained as colorless oil, $C_{20}H_{22}O_6$; ^{1}H-NMR ($CDCl_3$, 500 MHz): δ_H 3.13 (2H, m, H-1, 5), 4.76 (2H, d, *J* =3.9, H-2, 6), 3.89-4.27 (4H, dd, H-4, 8), 3.92 (6H, s, 2×OMe), 5.69 (2H, br. s, 2×OH), 6.92 (2H, br. s, H-2′, 2″), 6.91 (2H, d, H-5′, 5″), 6.85 (2H, dd, H-6′, 6″); ^{13}C-NMR ($CDCl_3$, 125 MHz): δ_C 146.6 (s, C-4′, 4″), 145.2 (s, C-3′, 3″), 132.8 (s, C-1′, 1″), 118.9 (d, C-6′, 6″), 114.2 (d, 5′, 5″), 108.5 (d, 2′, 2″), 85.8 (d, C-2, 6), 71.6 (t, C-4, 8), 55.9 (q, OMe), 54.1 (d, C-1, 5). (He *et al.*, 2001)

japonica acid (**10**) was obtained as white amorphous powder, $C_{18}H_{26}O_4$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 7.46-7.34 (2H, m, H-11, 14), 6.77, 6.75 (each 1H, br. d, *J* =3.1, H-12, 13), 6.40, 6.50 (each 1H, d, *J* =15.5, H-10, 15), 2.56 (2H, q, H-17), 2.52 (2H, t, *J* =7.2, H-8), 2.50 (2H, t, *J* =7.2, H-2), 1.80-1.61 (4H, m, H-3, 7), 1.36-1.24 (6H, m, H-4, 5, 6), 1.08 (3H, t, *J* =7.2, H-18); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 176.0 (s, C-1), 34.8 (t, C-2), 25.5 (t, C-3), 29.5 (t, C-4), 29.4 (t, C-5), 29.3 (t, C-6), 24.4 (t, C-7), 40.9 (t, C-8), 200.0 (s, C-9), 138.7 (C-10), 140.6 (d, C-11), 132.8 (d, C-12),

132.5 (d, C-13), 140.5 (d, C-14), 138.7 (C-15), 200.2 (s, C-16), 34.0 (t, C-17), 8.2 (q, C-18). (Wu *et al.*, 1998)

lutein (**11**) was obtained as red amorphous powder, $C_{40}H_{56}O_2$; ESI-MS *m/z*: 569 $[M-H]^+$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 6.92-6.84 (2H, m, H-11, 11′), 6.65 (2H, d, *J* = 15.2, H-15, 15′), 6.51-6.32 (6H, m, H-8, 8′, 10, 10′, 12, 12′), 5.96 (1H, s, H-4′), 5.64 (1H, ddd-like, *J* = 15.2, 10.3, 9.8, H-7′), 4.62 (1H, br.s, H-3′), 4.36-4.30 (1H, m, H-3), 2.65 (1H, dd, *J* = 17.2, 5.4, H-4a), 2.53 (1H, d, *J* = 10.3, H-6′), 2.43 (1H, dd, *J* = 17.2, 9.8, H-4b), 2.06 (3H, s, H-18′), 2.03 (6H, d, *J* = 4.9, H-19′, 20′), 1.99 (3H, s, H-20), 1.84 (3H, s, H-19), 1.71 (3H, s, H-18), 1.19 (3H, s, H-16), 1.18 (3H, s, H-17), 1.13 (3H, s, H-17′), 0.95 (3H, s, H-16′); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 37.6 (s, C-1), 49.9 (t, C-2), 64.3 (d, C-3), 44.1 (t, C-4), 126.1 (s, C-5), 137.3 (s, C-6), 138.5 (d, C-7), 138.3 (d, C-8), 136.2 (s, C-9), 131.3 (d, C-10), 124.2 (d, C-11), 137.3 (d, C-12), 136.5 (s, C-13), 132.5 (d, C-14), 130.4 (d, C-15), 29.3 (q, C-16), 30.3 (q, C-17), 22.3 (q, C-18), 13.2 (q, C-19), 13.26 (q, C-20), 34.8 (s, C-1′), 46.2 (t, C-2′), 65.3 (d, C-3′), 126.0 (s, C-4′), 133.7 (s, C-5′), 55.7 (d, C-6′), 131.3 (d, C-7′), 128.0 (d, C-8′), 133.7 (s, C-9′), 127.8 (d, C-10′), 126.9 (d, C-11′), 138.4 (d, C-12′), 138.5 (s, C-13′), 131.9 (d, C-14′), 139.1 (d, C-15′), 24.6 (q, C-16′), 31.0 (q, C-17′), 23.4 (q, C-18′), 13.6 (q, C-19′), 13.3 (q, C-20′). (Baranyai *et al.*, 1981)

trilobatin (**12**) was obtained as yellow powder, $C_{22}H_{24}O_{10}$; ^{1}H-NMR (CD_3OD, 500 MHz): δ_H 7.06 (2H, d, *J* = 8.8, H-2′, 6′), 6.69 (2H, d, *J* = 8.8, H-3′, 5′), 6.19 (1H, d, *J* = 2.2, H-6), 5.97 (1H, d, *J* = 2.2, H-8), 5.05 (1H, d, *J* = 7.1, H-1″), 3.92 (1H, dd, *J* = 12.0, 1.6, H-2″), 3.73 (1H, dd, *J* = 12.1, 5.5, H-5″), 3.52-3.38 (2H, m, H-3″, 4″), 3.35 (3H, s, OMe), 2.87 (2H, t, *J* = 7.7, H-6″); ^{13}C-NMR (CD_3OD, 125 MHz): δ_C 30.8 (t, C-2), 47.0 (t, C-3), 206.6 (s, C-4), 165.9 (s, C-5), 98.5 (d, C-6), 167.5 (s, C-7), 95.5 (d, C-8), 162.3 (s, C-9), 106.8 (s, C-10), 134.0 (s, C-1′), 130.5 (d, C-2′, 6′), 116.2 (d, C-3′, 5′), 156.3 (s, C-4′), 102.0 (d, C-1″), 74.7 (d, C-2″), 78.4 (d, C-3″), 71.1 (d, C-4″), 78.5 (d, C-5″), 62.4 (t, C-6″). (Tanaka *et al.*, 1982)

3-phenyl-1-(2′, 6′-dihydroxy-phenyl-4′-*O*-β-*D*-glucopyranosyl)-1-propanone (**13**) was obtained as yellow powder, $C_{21}H_{24}O_9$; ^{1}H-NMR (CD_3OD, 500 MHz): δ_H 7.24 (4H, m, H-2′, 3′, 5′, 6′), 7.13 (1H, m, H-4′), 6.18 (1H, d, *J* = 2.2, H-6), 6.95 (1H, d, *J* = 2.2, H-8), 5.03 (1H, d, *J* = 7.1, H-1″), 3.90 (1H, dd, *J* = 12.1, 2.2, H-6″), 3.70 (1H, dd, *J* = 12.1, 5.5, H-6″), 3.30 (2H, overlapped, H-3), 3.52-3.35 (3H, m, H-3′, 4′, 5′), 2.97 (2H, t, H-2); ^{13}C-NMR (CD_3OD, 125 MHz): δ_C 31.7 (t, C-2), 46.6 (t, C-3), 206.4 (s, C-4), 162.5 (s, C-5), 98.5 (d, C-6), 167.7 (s, C-7), 95.7 (d, C-8), 166.1 (s, C-9), 107.0 (s, C-10), 143.2 (s, C-1′), 129.6 (d, C-2′, 6′), 129.5 (d, C-3′, 5′), 126.9 (d, C-5′), 102.3 (d, C-1″), 74.9 (d, C-2′), 78.6 (d, C-3′), 71.3 (d, C-4′), 78.6 (d, C-5′), 62.6 (t, C-6″). (Hegde *et al.*, 2003)

naringenin-7-*O*-β-*D*-glucopyranoside (**14**) was obtained as yellow amorphous powder, $C_{21}H_{22}O_{10}$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 7.51 (2H, d, *J* = 8.6, H-2′, 6′), 7.21 (2H, d, *J* = 8.6, H-3′, 5′), 6.61 (1H, d, *J* = 2.2, H-8), 6.58 (1H, d, *J* = 2.2, H-6), 5.75 (1H, d, *J* = 7.8, H-1′), 5.42 (1H, dd, *J* = 12.6, 2.7, H-2), 4.50-4.13 (6H, m, H-2′ to 6′), 3.29 (1H, dd, *J* = 12.6, 16.9, H-3β), 2.89 (1H, dd, *J* = 16.9, 3.0, H-3α); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 80.0 (d, C-2), 43.5 (t, C-3), 197.5 (s, C-4), 166.9 (s, C-5), 97.9 (d, C-6), 164.8 (s, C-7), 96.7 (d, C-8), 163.9 (s, C-9), 104.6 (s, C-10), 129.8 (s, C-1′), 129.2 (d, C-2′, 6′), 116.7 (d, C-3′, 5′), 159.9 (s, C-4′), 101.8 (d, C-1″), 75.0 (d, C-2″), 78.6 (d, C-3″), 71.2 (d, C-4″), 79.3 (d, C-5″), 62.4 (t, C-6″). (Lu *et al.*, 2007)

vitexin (**8-*C*-β-*D*-glucopyranosyl apigenin**) (**15**) was obtained as yellow amorphous powder, $C_{21}H_{20}O_{10}$; ^{1}H-NMR (DMSO-d_6, 500 MHz): δ_H 8.02 (2H, d, *J* = 8.8, H-2′, 6′), 6.89 (2H, d, *J* = 8.8, H-3′, 5′), 6.78 (1H, s, H-3), 6.27 (1H, s, H-6), 5.06 (1H, d, *J* = 5.3, H-1″), 5.03 (1H, d, *J* = 4.1, H-1″), 4.67 (2H, m, H-2″, 5″), 3.83 (1H, t, *J* = 9.4, H-3″), 3.76 (1H, m, H-4″), 3.25 (2H, m, H-6″); ^{13}C-NMR (DMSO-d_6, 125 MHz): δ_C 164.1 (s, C-2), 102.5 (d, C-3), 182.2 (s, C-4), 160.5 (s, C-5), 98.2 (d, C-6), 162.7 (s, C-7), 104.1 (s, C-8), 156.1 (s, C-9), 104.7 (s, C-10), 121.7 (s, C-1′), 129.1 (d, C-2′, 6′), 115.9 (d, C-3′, 5′), 161.2 (C-4′), 73.5 (d, C-1″), 70.6 (d, C-2″), 78.7 (d, C-3″), 70.9 (d, C-4″), 81.9 (d, C-5″), 61.4 (t, C-6″). (Hu *et al.*, 2006)

7-*O*-β-*D*-glucopyranosyl chrysin (**16**) was obtained as yellow amorphous powder, $C_{21}H_{20}O_9$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 7.92 (1H, d, *J* = 1.3, H-2′), 7.90 (1H, d, *J* = 1.9, H-6′), 7.50 (1H, d, *J* = 2.4,

H-6), 7.45 (3H, m, H-3′, 4′, 5′), 7.05 (1H, d, J = 2.4, H-3), 6.96 (1H, s, H-8), 5.43 (1H, d, J =7.5, H-1″), 4.46 (1H, m, H-2″), 4.42-4.36 (4H, m, H-4′, 5′, 6′), 4.06 (1H, m, H-3″); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 165.0 (s, C-2), 109.9 (d, C-3), 178.5 (s, C-4), 160.6 (s, C-5), 105.8 (d, C-6), 161.8 (s, C-7), 99.8 (d, C-8), 160.0 (s, C-9), 109.3 (s, C-10), 132.0 (s, C-1′), 132.1 (d, C-4′), 129.6 (d, C-3′, 5′), 126.8 (d, C-2′, 6′), 106.9 (d, C-1″), 75.7 (d, C-2″), 77.9 (d, C-3″), 71.4 (d, C-4″), 79.7 (d, C-5″), 62.7 (t, C-6″). (El *et al.*, 2004)

isorhamnetin 3-*O*-α-*L*-rhamnopyranosyl-7-*O*-β-*D*-glucopyranoside (**17**) was obtained as yellow powder, $C_{28}H_{32}O_{16}$; ^{1}H-NMR (CD_3OD, 500 MHz): δ_H 7.95 (1H, d, J =1.7, H-2′), 7.63 (1H, dd, J =8.8, 1.7, H-6′), 6.92 (1H, d, J =8.8, H-5′), 6.42 (1H, d, J = 2.2, H-8), 6.22 (1H, d, J =2.2, H-6), 5.24 (1H, d, J =7.1, H-1″), 4.53 (1H, s, H-1‴), 3.95 (3H, s, OMe), 3.82 (1H, d, J =11.0, H-2‴), 3.61 (1H, s, H-2″), 3.50-3.24 (6H, m, H-3″, 3‴, 4″, 4‴, 5″, 5‴), 1.10 (3H, d, J =6.6, H-6″); ^{13}C-NMR (CD_3OD, 125 MHz): δ_C 159.1 (s, C-2), 135.6 (s, C-3), 179.5 (s, C-4), 163.2 (s, C-5), 100.1 (d, C-6), 166.2 (s, C-7), 95.1 (d, C-8), 158.7 (s, C-9), 105.9 (s, C-10), 123.2 (s, C-1′), 114.7 (d, C-2′), 148.5 (s, C-3′), 151.0 (s, C-4′), 116.3 (d, C-5′), 124.2 (d, C-6′), 104.5 (d, C-1″), 74.0 (d, C-2″), 76.1 (d, C-3″), 69.9 (d, C-4″), 77.5 (C-5″), 68.7 (t, C-6″), 102.7 (d, C-1‴), 72.2 (d, C-2‴), 78.3 (d, C-3‴), 72.4 (d, C-4‴), 71.8 (d, C-5‴), 18.0 (q, C-6‴), 57.0 (q, OMe). (Wolbis, 1989)

kaempferol-3-*O*-β-*D*-glucopyranoside (**18**) was obtained as yellow amorphous powder, $C_{21}H_{20}O_{11}$; ^{1}H-NMR (Pyridine-d_5, 500 MHz): δ_H 8.43 (2H, d, J = 9.0, H-2′, 6′), 7.19 (1H, d, J =7.2, H-8), 6.70 (2H, dd, J =7.2, 2.0, H-3′, 5′), 6.32 (1H, d, J = 7.2, H-6), 4.40-4.03 (6H, m, H-sugar); ^{13}C-NMR (Pyridine-d_5, 125 MHz): δ_C 157.7 (s, C-2), 135.2 (s, C-3), 178.9 (s, C-4), 157.5 (s, C-5), 99.9 (s, d, C-6), 166.0 (s, C-7), 94.7 (d, C-8), 162.9 (s, C-9), 105.4 (s, C-10), 122.1 (s, C-1′), 132.0 (d, C-2′, 6′), 116.2 (d, C-3′, 5′), 161.7 (s, C-4′), 104.0 (d, C-1″), 79.2 (d, C-5″), 78.5 (d, C-3″), 76.1 (d, C-2″), 71.5 (d, C-4″), 62.6 (t, C-6″). (Chen *et al.*, 2009)

kaempferol-3-*O*-β-*D*-(6″-*O*-trans-p-coumaroyl) glucopyranoside (**19**) was obtained as yellow amorphous powder, $C_{30}H_{26}O_{13}$; ^{1}H-NMR (CD_3OD, 500 MHz): δ_H 7.91 (2H, d, J =8.9, H-2′, 6′), 7.34 (1H, d, J = 15.9, H-3‴), 7.22 (2H, d, J =8.5, H-5‴, 9‴), 6.74 (2H, d, J =8.9, H-3′, 5′), 6.72 (2H, d, J =8.5, H-6‴, 8‴), 6.20 (1H, d, J =1.9, H-8), 6.05 (1H, d, J =2.1, H-6), 6.02 (1H, d, J = 15.9, H-2‴), 5.20 (1H, dd, J =1.9, 5.6, H-1″); ^{13}C-NMR (CD_3OD, 125 MHz): δ_C159.3 (s, C-2), 135.4 (s, C-3), 179.4 (s, C-4), 162.9 (s, C-5), 100.0 (d, C-6), 165.9 (s, C-7), 95.0 (d, C-8), 158.3 (s, C-9), 105.6 (s, C-10), 122.7 (s, C-1′), 132.3 (d, C-2′), 116.1 (d, C-3′), 161.6 (s, C-4′), 116.1 (d, C-5′), 132.3 (d, C-6′), 104.2 (d, C-1″), 78.1 (d, C-2″), 75.8 (d, C-3″), 71.8 (d, C-4″), 75.8 (d, C-5″), 64.5 (t, C-6″), 169.0 (s, C-1‴), 114.8 (d, C-2‴), 146.7 (d, C-3‴), 127.1 (s, C-4‴), 131.3 (d, C-5‴), 116.9 (d, C-6‴), 161.2 (s, C-7‴), 116.9 (d, C-8‴), 131.3 (d, C-9‴). (Tsukamoto *et al.*, 2004)

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《云南植物研究》征订启事

《云南植物研究》创刊于 1979 年，是由中国科学院主管、中国科学院昆明植物研究所承办的全国性自然科学学术期刊。经过 30 年的努力，现已成为我国植物科学研究发表论文的主要学术性刊物之一，已被选为“中国自然科学核心期刊”，“中国生物学类科技核心期刊”。本刊荣获中科院优秀期刊二等奖（1996）及一等奖（2000）、第二届全国优秀期刊三等奖（1997）及云南省优秀科技期刊一等奖（1997）等，并作为中国科学院首批向美国 SCI 推荐的刊物之一，2002 年入选国家“双效期刊”。本刊所发表的论文在国内生物、农林、医药、轻工等二次文献刊物都有摘报；国外 CA（美国化学文摘）、BA（美国生物学文摘）等从 1980 年起就连续摘报；生物科学的当代进展（CABS）、科学引文索引（SCI）的 CI 部分以及俄罗斯文摘杂志（РЖ）和国际农业科技情报系统（Agris）等都有摘报；乌利希国际期刊指南（UIPD）从 80 年代就刊载本刊出版事宜。本刊已同 30 多个国家和地区有发行和交换关系，在国内外同行中有一定的影响。目前已加中国学术期刊光盘版、中国学术期刊网及万方数据库资源系统。本刊主要报道植物学各分支学科具有创造性或较高学术水平的研究论文和简报；植物学领域的新发现及重大应用价值的新成果；有关植物学资源开发利用和保护的创新性研究成果；植物学研究的新技术、新方法；反映本学科重要领域的国内外植物科学研究的最新进展的评述，中英文稿件均受欢迎。本刊设有植物系统学与生物地理学、植物化学与化学生物学、生物多样性保护与民族植物学、植物生态学与资源管理、植物生理与分子生物学 5 个专栏。

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